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U.S. Insurance Industry Perspectives on Global Climate Change

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Synopsis

In this report we explore the disposition of the U.S. insurance community regarding the question of global climate change. To provide some context, we examine the history of insurance, insurance regulation, the role of government insurance and disaster relief, the relationship between insurer insolvencies and weather-related events, the emerging capital market alternatives to finance risk, and insurers' perception of and participation in climate science and catastrophe modeling. While it is generally recognized that weather-related catastrophe losses have been rising dramatically in recent years, the role of climate change in past or future trends is a subject of much uncertainty for insurers. Our in-depth interviews with insurance executives and extensive review of the literature found that insurers have assumed positions on all points of the public policy compass. This report has been prepared in the spirit of fostering improved understanding and communication among the insurance and non-insurance communities, and perhaps a higher level of interaction than has been seen thus far.

The world's nations have endured nearly one trillion dollars in economic losses (and 560,000 fatalities) due to 8,800 natural disasters over the past fifteen years. Three-quarters of the loss costs were weather-related, and a fifth were insured. Over the past 50 years, the number of weather-related natural disasters has been steadily rising, as have the total and insured losses. Nearly 60% of these losses are visited on U.S.-based companies, and between 1970 and 1999 losses (adjusted for inflation) grew nine-times faster than population. Meanwhile, the insured fraction of total losses has increased steadily, as has the size of those losses in relation to premium income.

Weather-related events touch almost all types of insurance providers, although the degree of vulnerability varies substantially. Property insurers are more vulnerable than are life and health insurers, and within the diverse property segment some insurance lines are more vulnerable than others. While the total available reserves are large compared to catastrophe losses experienced in the past, not all of these funds are available to pay such losses. In fact, about 90% of these reserves are associated with types of insurance that have relatively little if any weather-related exposure (e.g., workers compensation, medical malpractice, liability).

The effects of increased losses can lead to pressure on insurance reserves and prices, sensitivity of insurers' stock prices to major weather-related events, and an increasing number of insolvencies. Large and small insurers alike have been impacted by weather extremes and will be more so in the future if the frequency or intensity of weather-related events increases. The continued insurability of such risks is a central question, especially given that most experts project increases in extreme events going forward.

One of the vexing dilemmas facing insurers is the difficulty of disentangeling the causes of weather-related loss events. This is especially true for those potentially related to human-induced climate change versus natural climate cycles, and those having to do with human activity that could accelerate or dampen the process (demographic trends, increasing property values, disaster mitigation efforts, etc.). In many cases, upward trends in losses have shown to be a product of both human and climatological factors, but an in-depth understanding is hampered by technical complexity and insufficient information. Compounding the problem, climate change research is rarely conducted with insurers in mind.

The words "Climate Change" stir anxieties and arouse controversies among insurers. While a number have given some attention to the issue, the vast majority of individual firms and most trade organizations have not indicated an opinion (at least not in a public forum). A few have taken definitive positions that there is a material threat, while others have adopted equally strong views to the contrary. Some have elected to pursue research and the fortification of society against climate change, and others to adopt a "wait-and-see" stance. U.S. insurer involvement in

the issue was greater in the mid-1990s than it is today, with many insurers paralyzed by conflicting reportage on the topic and skeptical about the political and scientific assessments of climate change.

Insurers have a number of tools for reducing their financial vulnerability. These include purchasing reinsurance, raising rates, non-renewal of existing policies, and the cessation of writing new policies. They may also limit their liability by capping amounts of insurance available, placing special limits of liability on coverage, providing coverage on an "actual cash value" basis (taking deductions for depreciation holders and/or betterment) instead of paying for the replacement cost, and increasing the deductibles paid by their customers. They may also pool their risks and strive to increase their investment income, and, if sufficiently burdened, reduce dividends to shareholders and/or policyholders. Implementing some of these measures may require legislative or regulatory action and present possible political and market risks. Meanwhile, insurers—in consort with other parties—also possess a diverse toolkit of engineering approaches to managing and minimizing the losses caused by natural hazards. These include use of geographic information systems to better understand and pinpoint risks, land-use planning, flood control programs, early warning systems, sustainable forest management, coastal defense, and wind-resistant construction techniques supported by building codes. However, some within the industry question whether even the combined effect of these types of loss control are sufficient.

Insurers are also able to transfer loss costs to governments, self-insureds, consumers, and the capital markets. Insurers point out, rightfully, that not all risks are commercially insurable in a market economy. Seeking reductions in private sector insurance coverage for climate- and weather-related hazards produces increased pressure on government to assume the associated risks. Governments, however, have repeatedly shown reluctance to increase their existing insurance exposures and liabilities for providing disaster relief. This tension is a central dilemma facing society in the face of rising catastrophe losses.

Although the notions of risk management and loss prevention are embedded in the historical fiber of the insurance industry, U.S. insurers have yet to fully extend this thinking to the matter of climate change. Insurers have treated loss control as a relatively "local" enterprise, whereas it would entail a rather dramatic shift in self-perception for insurers to engage in the activity at a (literally) global scale. Moreover, we have seen no quantitative analyses of how climate changes could effect the "probable maximum loss" estimates upon which insurance pricing and planning rest.

With some notable exceptions, the preponderance of existing U.S. insurer activities fall in the area of pre- and post-disaster loss mitigation, rather than involvement in climate science or mitigating the potential effects of climate change itself. An important semantic point is that while the climate-change research community uses the word "mitigation" to refer to measures that promise to *reduce the process* of climate change, the insurance community uses the term to refer to measures that *reduce the likelihood of losses* from climate-related (and other) events.

Nonetheless, many of the insurance executives we interviewed exhibit a genuine desire to make a contribution toward safe-guarding the public and their policyholders. However, most claim to lack the scientific knowledge needed to participate in the climate-change debate. Ironically, some stridently declare a lack of expertise and in the same breath state with authority that climate change is not taking place.

Over the past decade, U.S. insurers, to their credit, have been involved in a large number of activities in which the question of weather-related losses (and in some cases climate change itself) have been addressed. While this evidences considerably more involvement than many outside the insurance community are aware of, what does not emerge is a sense that these events have built upon one another towards some sort of consensus on the matter or towards a coordinated plan of action extending beyond preliminary discussion and fact-finding activities.

Given the potential for disruption caused by climate change, it is notable how limited U.S. insurer activities have been (at least as is evidenced in the public record) to analyze the problem. At the highest level, we discern three basic types of "perceptual

barriers" to more in-depth insurer involvement and collaboration with non-insurer groups. These include: (1) uncertainties regarding the science of climate change, (2) distrust, emanating from parochialism and provincialism among stakeholders; and (3) lack of knowledge and the failure to fully understand stemming from insufficient dialog among stakeholder groups. Underlying these, we identify an extensive series of barriers that fall into the categories of "legal and regulatory", "technical and informational", "economic and market", and "political".

We touch on the sometimes remarkable differences between the activities and statements of U.S. and non-U.S. insurers. These include the relative weight of green marketing and green politics, the role of governments in natural disasters, conceptual approaches to loss prevention and mitigation, and the perception of new business *opportunities* presented by climate change risks. Likewise the regulatory and tax-law environment, as well as the tone and tenor of government relations with insurers, and differences in corporate culture and the timeframes with which insurers measure their futures can differ dramatically among countries. It was 28 years ago that European insurers first articulated concern about climate change (16 years before their U.S. colleagues first publicly addressed the issue). Yet, it is also fair to say that, in a few select ways, U.S. insurers are ahead of their European counterparts.

Non-insurer organizations in the U.S. often evidence little appreciation for differences in conditions faced by U.S. and overseas insurers. Although generally well intentioned, we find that efforts to involve insurers in the climate change discussion have met with very limited success. We believe that the problem stems in part from non-insurers' lack of knowledge about the intricacies of the insurance business, i.e., its history, regulation; the common misperception that insurers are a monolithic group and occasional overstatement of the facts on climate change. Meanwhile, mutual understanding is also hampered by insurer perceptions that these groups are politically rather than scientifically motivated or that non-insurers cannot bring true value to their core business.

It appears that differences in worldview and analytical orientation have served to separate many insurers and non-insurers on the question of climate change. Some of these differences may prove irreconcilable, but others certainly stand to be bridged through increased mutual understanding and interdisciplinary, cooperative research and inquiry. Both communities—and their constituencies—no doubt stand to benefit from engaging with the other in a more comprehensive dialog. From various quarters within the insurance community, we are already hearing a call for a more holistic approach, one that integrates no-regrets environmental protection with the discipline of disaster risk management.

Executive Summary

Globally, society has endured nearly one trillion dollars in economic losses[1] due to natural disasters over the past fifteen years alone—about a fifth of which were insured and three-quarters of which were due to weather-related events. These losses—also evidenced over a longer 50-year timeframe—are on the rise, as is the share of premium revenue represented by these losses. A multiplicity of factors contribute to the scale and rate of change in losses, ranging from economic and demographic trends, to market factors, to changes in the nature of natural disasters themselves.

In recent years, various parties outside the insurance community—e.g. government entities, scientists, and environmental groups—have sought to engage the $2.2-trillion-dollar global insurance industry[2] in the climate change discussion. Among these non-insurance groups, some have argued that climate changes could expose insurers to devastating losses. Others have alerted insurers to new business opportunities and other co-benefits stemming from climate change mitigation. Although well-intentioned, these efforts have generally met with limited success. We believe that the problem stems in part from non-insurers' lack of knowledge about the intricacies of the insurance business, e.g., its history and regulation; a misperception that insurers are a monolithic group; and lack of awareness of the variety of risk management tools available to insurers. Non-insurers also tend to have an incomplete grasp of past and present insurer involvement in the issue of climate change, and of the different political and market conditions faced by overseas insurers who appear to be more involved in the issue. On the other side of the divide, insurers—like any specialized community—do not always embrace multi-stakeholder collaborations. Some insurers also perceive the non-insurer groups as politically rather than scientifically motivated, and as insensitive to their basic needs and constraints as businesses. With these differences in mind, this report has been prepared in the spirit of fostering improved understanding and communication within and among these communities.

While our central focus is on the U.S. insurance community, we also focus on the government sector as insurer and regulator of insurers, and thus an integral part of the risk-management equation.

Where applicable we draw upon experiences of overseas insurers and upon global insurance data. It is worth bearing in mind that as the insurance market becomes increasingly interconnected, national borders will play a reduced role in characterizing the industry and the risks it faces. U.S. insurers collected $35 billion in premiums for overseas insurance sales in 1997 (approaching 15% of total premiums), and this business has been growing faster than overall premiums in recent years. Overseas insurers can also be impacted by events within the U.S. As a case in point, largely as a result of the U.S. environmental liability crisis (Superfund), natural disasters, and various oil industry disasters, Lloyd's of London experienced a pronounced 13-year period of mostly negative profitability from 1980 to 1993.

[1] According to Munich Re, total economic losses are dominated by direct damages, defined as damage to fixed assets (including property or crops), capital, and inventories of finished and semi-finished goods or raw materials which occur simultaneously or as a direct consequence of the natural phenomenon causing a disaster. Economic loss data can also include indirect or other secondary damages such as business interruptions or temporary relocation expenses for displaced households. More loosely-related damages such as impacts on national GDP are not included. In the U.S., Property Claim Services (PCS) definitions of losses set minimum thresholds for inclusion of $5 million up to 1996, and $25 million subsequently. As a result, no winter storms were included in the statistics for the 46-year period of 1949-1974, and few were included thereafter (Kunkel *et al.* 1999). Although large in aggregate, highly diffuse losses due to structural damages from land subsidence would also rarely be captured in these statistics. Similarly, weather-related vehicle losses are typically not captured in the statistics. Thus the totals presented here are underestimates of actual losses.

[2] This includes premiums collected by the two major branches of the industry: property/casualty and life/health insurers. The relative sizes of these branches, and the relevance of climate-related losses for each are discussed in this report.

Approach and Organization of the Report

This report focuses primarily on factors shaping U.S. property/casualty insurer perspectives on the matter of climate change, with a central aim to help-foster a higher level and quality of understanding and interaction between the insurance and non-insurance communities. The life/health segment is treated only peripherally, although it too is vulnerable to weather and climate-related loss events.

While this report is intended primarily to help orient non-insurers to the insurance market, it may also serve insurers who have not already explored the climate change question in depth.

To initiate our inquiry, we touch upon the history of insurance and the organizational structure and regulation of the business. We examine numerous important chapters in the history of insurance, including the advent of the multi-peril policy and "Standards of Insurability" that determine whether insuring a risk is seen as commercially viable.[3]

We then review the various potential causes of change in the patterns of weather-related losses and loss costs, including the impact of increasing and shifting populations and exposures. We also discuss the function and relevance of government insurance and public policies that interact with the private-sector insurance marketplace. We survey the emerging non-insurance alternatives for financing risk, and describe the challenges insurers face in seeking regulated rates that are adequate to pay future losses. We review the trend towards "cash flow-underwriting" and related concerns about the future availability and viability of reinsurance. We also identify factors and barriers that shape the minds and attitudes of insurance leaders. In addition—in the main text with additional key material in Appendix B—our review considers insurer's interaction with the science of climate and catastrophe modeling.

At the core of the report, we present the results of interviews with 17 insurance executives to explore insurer perspectives in-depth. A number of those interviewed requested anonymity, and we respect that in our account. This report is also underpinned by a review of over 300 publications from the scientific and insurance trade literature.

A note about our approach is in order. Our aim is to describe the historic and present-day disposition of the U.S. insurance community regarding the question of climate change. In the course of our interviews and other information-gathering activities, we received input from several dozen insurance firms and organizations. In these discussions, we encountered tremendous variability in the nature and degree of interest in the climate change issue. Our intention is to synthesize, analyze, and report all that we learned for the benefit of the reader. The result naturally depicts a diversity of opinions and perspectives, rather than a polished and internally consistent "position". This is not intended as a criticism of insurers, but rather as a stock-taking exercise that will help all concerned parties move forward in a constructive fashion. The knowledge base from which we could draw is by definition limited to what insurers would share with us verbally or what is documented in the public domain. A number of leaders in the insurance and financial services communities were invited to provide peer review comments on a draft of this manuscript, and we are grateful to those who took the time to do so.

[3] The standards of insurability include: (1) There should be a large number of homogeneous exposures to permit the operation of the theory of probability and setting of actuarial rates (law of large numbers). (2) The occurrence should be fortuitous: i.e. the timing or the severity of the loss should be out of the control of the insured. (3) The peril must produce a loss definite in time and amount. The insurer must be able to verify the loss promptly and measure its magnitude. (4) The insured group of risks must not be exposed to an incalculable catastrophe hazard. There must not be a significant concentration of values in vulnerable areas. (5) The premium must be reasonable in relation to the potential financial loss (priced to attract purchasers), and, simultaneously, develop the actuarially sound premiums necessary to cover the losses while providing for insurer solvency.

History Shapes the Minds and Attitudes of Insurers

Formal insurer attention to weather-related losses is a relatively recent development in the history of the U.S. property/casualty insurance industry. Historically focused on insuring a single peril, "fire", it was only within the last fifty years that U.S. underwriters engaged extensively in insuring other causes of natural hazard events. Natural disaster loss mitigation, in practice, has not reached the level of refinement as it has in the case of fire. Since broadening their focus from insuring only fire, insurers have assumed a potpourri of losses from weather-related events, such as hurricanes, cyclones, tornadoes, severe windstorms, hail and ice storms, rainstorms, floods, tidal surges, heat waves, soil subsidence, erosion, etc. Compared to the fire peril, only fragmented knowledge and few underwriting criteria exist for these events.

Events have shown that these hazards can cause catastrophic direct loss and significant consequential losses such as, fires and wildfires, business interruption, food spoilage, and losses associated with additional living expenses. Climate change (be it natural or caused by human activities) increases actuarial uncertainty and therefore financial risks for insurers.

Insurers have had considerable involvement with "loss prevention" and it is in fact an integral part of their history, via fire safety programs and the like. Insurance loss prevention, however, has generally focused on arming the individual against risk rather than reducing the risk itself. Stated another way, insurer catastrophe loss mitigation efforts have striven to lessen structural and content losses, but generally, exclusive of the "fire peril", have not attempted to eliminate or reduce the root peril or hazard causing the occurrence.

Going forward, it must be kept in mind that insurers face many issues and pressures aside from the question of potential changes in natural catastrophes, some of which are perceived as more pressing. Examples include current trends towards consolidation and convergence between banking and insurance — although these too can have beneficial or adverse impacts on a firm's financial fitness and vulnerability to catastrophes, a point that has not gone unnoticed by insurers.

Government's role in providing insurance and disaster prevention/recovery aid is an important and growing part of the equation. Discussion and analysis of insurance and climate change thus must weigh the nature and importance of government involvement. According to one estimate, U.S. government disaster-related payments amounted to $119 billion ($1993) for the 1977-1993 period. If climate risks rise, insurers will likely look to governments to play an increasing role in assuming those perils and/or hazards that produce catastrophic losses. However, government's past and current efforts to limit and even reduce financial support following natural disasters indicates their ambivalence toward assuming additional risks. As evidence of the challenges facing the U.S. government, their insurance programs for crop and flood have not been able to attain solvency. The current-day debate over federal catastrophe reinsurance further evidences the difficulty in finding an acceptable balance for risk sharing between the public and private sectors.

Insurer Vulnerability to Climate Change is Real, but Difficult to Quantify

There is a clear upward trend in global weather-related losses, even when adjusting for inflation. An "average" year these days produces 5.5-times as many weather-related natural disasters, globally, than 40 years ago, resulting in 13.6-times the insurance losses, adjusted for inflation, or $9.2 billion per year in the 1990s. In the fifteen-year period between 1985 and 1999 over 8,800 weather-related catastrophes took place around the world. Globally, 31% of the total economic costs and 58% of the associated

insurance losses were visited on U.S. insurers. During this period, the ratio of global property insurance premium income to losses fell three-fold.

Over the past three decades, the majority of global insurance losses were absorbed by U.S.-based companies, and catastrophe losses (adjusted for inflation) grew by over seven-fold — i.e. nine-times faster than population. The ratio or premiums to catastrophe losses fell by six-fold in the U.S. over this period (and briefly by 20-fold following Hurricane Andrew).

Irrespective of the causes of past losses, a problem looking forward is that academic climate science is rarely designed to address the exact questions of importance to insurers. The growing popularity of catastrophe ("CAT") models is a step in the right direction, but these models are predicated largely on historical data rather than scenarios incorporating future climate change, and there is regulatory resistance to the use of these models for setting insurance premiums.

For insurers, vulnerability can be broadly viewed in terms of the relationship between probable maximum losses (PMLs), the sector's capacity to pay for these losses, and its ability to recharge depleted reserves and surplus (net assets), taken together with the predictability and uncertainty of such events. The cyclic nature of the insurance industry (prices and reserves) intrinsically leads to periods of higher-than-average vulnerability. While the ultimate manifestation of impacts for an insurer is insolvency (bankruptcy), catastrophes can disrupt insurance markets and harm insurance companies and consumers even in cases where all claims are paid. We have seen no quantitative analyses of the potential effects of climate change on PMLs.

The insurance sector is extremely diverse, with most branches vulnerable to climate/weather-related losses but to significantly varying degrees. Meaningful analyses must pinpoint the most vulnerable industry segments. Based on experience to-date, the property/casualty (P/C) segment is more vulnerable to weather-related events than the life/health segment. The single-most vulnerable sub-segment appears to be property insurance for structures. Other segments, such as personal automobile insurance, have more limited exposure. Less obvious vulnerabilities include impacts such as those from increasing lightning strikes on machinery breakdown and business interruption insurance.[4] As an indication of the diversity of indirect effects, industry groups have even cited social or economic instabilities caused by climate change as a potential trigger for "political risk" insurance claims, although the likelihood and magnitude of such losses is relatively low. Other types of insurance (e.g. medical malpractice) are unaffected by weather.

Before liquidating assets to pay losses, insurers can utilize "reserves". Reserves are formed based on historic loss experience and are not allowed to include extraordinary losses that might be expected in the future. According to A.M Best Co., as of 1999, property/casualty insurer reserves totaled $345 billion. While this amount is large compared to catastrophe losses experienced in the past, most of these funds are not available to pay such losses. In fact, the majority of these reserves are associated with types of insurance that have relatively little if any weather-related exposure (e.g. workers compensation, medical malpractice, liability). Reserves for the most vulnerable lines: commercial multi-peril and homeowners multi-peril were approximately $37 billion (11% of the total), with an additional $6 billion provided through reinsurance.

Overall capacity, measured in terms of surplus ("net assets"), varies considerably over time with the industry's core business and the performance of the financial markets in which many of their assets are located. A significant increase was seen during the 1990s, thanks to regular growth and the bull market.

While much emphasis is placed on the largest and most destructive weather events, often referred to as "mega-catastrophes" within the insurance community, small weather-related losses are also important. In fact, such small events represent one-half of all weather-related insurance losses.

Further complicating matters, from an actuarial standpoint, climate changes can imply greater statistical uncertainty (unpredictability) concerning potential losses and an unclear "pathway" between

[4] Lightning has been cited as responsible for five percent of (presumably property) insurance claims (Kithil 1995), which would be approximately $9 billion annually. Reve and Toumi (1999) have shown that a 1-degree-C increase in average wet-bulb temperature can be accompanied in mid latitudes by a 40% increase in lightning. Price and Rind (1993) found that in a 2xCO_2 climate with a 4.2-degrees-C warming, global cloud-to-ground lightning strikes would increase by 72% over continential regions.

present and future climate regimes. This uncertainty in and of itself represents an adverse and undesirable aspect of climate change.

One of the vexing dilemmas is that it is not easy to disentangle the relative causes of these losses, especially those potentially related to human-induced climate change (versus natural climate cycles) and those related to human activity that could accelerate the adverse effects of natural phenomenon. These adverse effects include demographic trends, increasing property values, etc.[5] In many cases, upward trends in losses have shown to be a product of both human and climatological factors.

On the other hand, considerable human efforts are made to avert or reduce natural disaster impacts, including mitigation along coastlines, cloud seeding to divert hail storms, improved building codes, tightened zoning, improved weather forecasting and storm warning systems, and public spending on disaster preparedness and recovery. While rarely if ever quantified or otherwise factored into studies of human versus natural causes of loss growth, these efforts can offset or obscure otherwise visible effects of climate change.

Comprehensive analyses of global insurance sector vulnerability to past or future climate changes have not been undertaken. A recent paper addressing this question was prepared by the American Insurance Association. AIA, a national trade organization of primarily large U.S. property-casualty insurers—representing approximately 20% of annual premium revenues for this segment—estimated that: 17% of U.S. insurance P/C premiums are associated with types of insurance with "significant" exposure to weather-related loss, 2% with "moderate" exposure, 66% with "minor" exposure,[6] 9% with "minor to no" exposure, and 4% with "no" exposure (AIA 1999).[7]

Studies such as AIAs are an important starting point, and highlight the need for segmenting and taking into account the financial complexity and diversity of the insurance sector, rather than regarding it as a monolith. Their study also points out the dominant role of hurricanes in the overall picture of weather-related losses in the U.S. and that a connection between hurricanes and climate has not been established. Moreover, the study notes the importance of proactive land-use planning and that certain measures normally thought of as climate change "mitigation" (e.g. emissions reduction achieved through public transportation or reduced highway speed limits) can also offer benefits to insurers by reducing everyday risks.

Individual firms may become insolvent long before losses approach the industry's aggregate capacity, even at a level of a $10-$20 billion-loss event in the case of the U.S. While reinsurers offer additional capacity, a general consensus as of the late 1990s suggested that the capacity of insurers and reinsurers to absorb a single major catastrophe, without major disruption, is distinctly limited as well.

The threat of insolvency is often assumed to apply exclusively to small firms. Following Hurricane Andrew, however, we observed that the country's largest homeowner property insurer, State Farm Fire & Casualty, was brought to the brink of insolvency, necessitating a rescue by its parent (State Farm Group). The same fate met Allstate, the nation's second largest homeowner insurer. Of the nearly 700 U.S. insurer insolvencies between 1969 and 1999, about 10% were primarily due to natural catastrophes, and for an unknown additional share catastrophes were a contributing but not primary factor.

Most analyses focus on single loss events, while in reality insurers can be faced with sequential losses or other sources of financial stress. Multiple extreme events in close spatial or temporal proximity constitute low-probability, high-consequence events for the industry. Severe non-weather-related events (e.g.

[5] Studies by Easterling *et al.* (2000), Changnon *et al.* (1997), and Pielke and Landsea (1998) have attempted to disentangle factors underlying the upward trend in weather related catastrophe claims (see Appendix B).

[6] This large segment is predominantly vehicle insurance. In the U.S., 16% of automobile accidents are attributed to adverse weather condition (NHTSA 1999), as are one-third of the accidents in Canada (White and Etkin 1997) and 43% in the U.K. (Barker *et al.* 1998). Vehicles also sustain insurance losses from natural disasters, averaging 10% of all catastrophe losses, or $3.4 billion and 1.7 million claims between 1/1996 and 9/2000, with auto losses in individual events ranging as high as 55% of the total. (PCS 2000).

[7] The full report can be found in Appendix E. The most sensitive customer segments are residential and commercial property, ocean marine, crop and farm-owners, and flood. Crop insurance and residential flood insurance are largely insured or reinsured by government. The paper did not evaluate other measures of vulnerability, such as profitability or solvency at the level of the firm or exposures according to other metrics, e.g. in terms of total insured property values for which the at-risk insurers are responsible—e.g. $4 trillion in insured property in the Gulf and Atlantic coastal counties of the U.S. (Hooke 2000). Losses from crop and flood insurance excluded because the risk is assumed by the federal government.

earthquakes), could also deplete a significant proportion of insurer reserves.

Moreover, vulnerability arises from the relative health of the insurance and broader financial sectors and markets prevailing at the time of a major catastrophic loss event. Major market fluctuations can have an adverse impact on insurer solvency. In the event of catastrophic losses, insurers may need to liquidate investments (a part of "surplus") in order to generate loss compensation. Coinciding broad-based stresses on the industry can directly influence vulnerability by eroding surplus. Such past or potential sources of stress include: major tobacco-related claims, the crisis in liability insurance (especially the "long-tail" U.S. Superfund and asbestos claims), increased competition from Internet sales, Internet privacy liability,[8] or world events such as the Asian financial crisis or elevated energy prices.

Insurance prices and stock values have exhibited sensitivity to disaster events. Aside from issues of solvency, past extreme weather events clearly have measurable short- to medium-term impacts on the availability of insurance and reinsurance following the disaster event and on insurance industry-wide profitability.

An overarching issue is that, from an actuarial standpoint, future disaster trends that develop in an unpredictable, non-linear manner can imply greater statistical uncertainty (unpredictability) of potential losses. This can present a material impediment to setting actuarially sound rates. Interrelated vulnerabilities arise from regulatory uncertainties, e.g. the inflexibility sometimes exhibited when insurers propose withdrawing from markets or raising insurance prices. Overlaid upon the preceding uncertainties, future climate and weather regimes will not necessarily represent a simple extrapolation of the risks as they are known today, and exposures are steadily increasing as people continue to move into harm's way.

Insurers Have Tools for Managing and Spreading Risk

Insurers have many tools for reducing their financial vulnerability to losses. These include financial mechanisms such as increasing surplus, raising prices, or denying policy renewals and new policies. Insurers can also limit the maximum losses that can be claimed by paying for the depreciated value of damaged property instead of the new-replacement value, by reducing dividends paid to shareholders, or by tightening deductibles (raising the floor or redefining them in percentage terms instead of fixed amounts). However, for technical as well as political reasons, insurance regulators have shown limited willingness to grant such allowances.

Similarly, insurers—in consort with other parties—spread risks through engineered risk management approaches, including use of geographic information systems to better understand and pinpoint risks, land-use planning, flood control programs, early warning systems, sustainable forest management, coastal defense, and wind-resistant construction techniques supported by building codes.

Insurers also spread risks among themselves by pooling risks via so-called Residual Market Mechanisms (FAIR Plans, Beach and Windstorm Plans, and Joint Underwriting Associations). These mechanisms represented insured property value (exposure) of $24 billion in 1970, rising to $285 billion in 1998.

Insurers also utilize mandated Guaranty Funds (a.k.a. "Insolvency Funds") through which solvent insurers must contribute to the payment of claims when member insurers become insolvent. Guaranty Funds were originally intended for small, specialized, and geographically concentrated firms but there has been a trend towards insolvencies and corresponding demand for guaranty fund resources among larger and more diversified companies. Payments from these funds have grown substantially in recent decades, with net assessments of $6.3 billion over the 1969-

[8] In the insurance trade press, the specter of Internet privacy litigation has been likened to the pollution liability (Superfund) crisis.

1998 period, and as much as $0.9 billion in a single year. Of the 25 largest U.S. P/C insolvencies (amounting to $5 billion in unpaid claims), only 29% of the losses were recoverable through guaranty funds and national capacity was only $3.4 billion as of 1998. Insurers who are not directly impacted by a catastrophic event, can thus experience a liability through their participation in Guaranty Funds.

Insurers spread risk even more widely by purchasing reinsurance, wherein reinsurers essentially assume a portion of the risks in exchange for part of the premium. Reinsurance is certainly a moderating force with respect to many of these vulnerabilities, although it is not a panacea. For example, an analysis conducted by the Swiss Reinsurance company concluded that the presence of reinsurance coverage for natural disasters in 14 major markets around the world (U.S. $53 billion) was insufficient.

Insurers can also spread risks to points entirely outside of the insurance industry. This is being promoted through a family of financial instruments collectively referred to as Alternative Risk Transfer (ART). These mechanisms include contingent surplus notes, catastrophe equity put options, catastrophe bonds, and catastrophe options. There are widely disparate views within and outside of the insurance sector concerning the potential for and efficacy of these instruments.

Lastly, many risks are passed to the government sector (including the local, state, and federal levels). Government has assumed the role of insurance provider in the past for risks that private insurers find uninsurable. These include certain crop and flood risks. Governments also provide disaster preparedness and recovery services, e.g. through the Federal Emergency Management Agency (FEMA) or the Small Business Administration's (SBA) disaster recovery loan program. The question of who assumes disaster risks is a "hot potato" tossed back and forth between insurers and the government.

While the above-mentioned tools have served society well and their value should not be underestimated, it is also clear that the specter of natural disasters is a growing concern for insurers and that existing risk management and spreading mechanisms are constantly being tested.

The Words "Climate Change" Stir Anxieties and Arouse Controversies among Insurers

U.S. insurers contend that they are interested in, and are constantly striving to acquire a better understanding of extreme natural hazard events. Yet, most stridently assert that they are not experts on climatological or meteorological matters. They vigorously resist being thrust into a role that would have them commenting on issues or problems on which they lack expertise. Insurers maintain that they have expertise in matters of loss control, reduction and/or prevention, and it is in this area that they view themselves as making a major contribution particularly relating to extreme events.

On the question of climate change, U.S. insurers can be found on all points of the public policy compass. While a number have given some attention to the issue, the vast majority of insurers and many trade organizations have not publicly indicated an opinion. A few have taken definitive positions believing that there is a material threat, while others have taken equally strong views to the contrary. Some have elected to pursue the fortification of society against natural perils, and others to adopt a "wait-and-see" stance.

Although the notions of risk management and loss prevention are embedded in the historical fiber of the insurance industry, U.S. insurers have yet to extend this thinking to the matter of climate change. Insurers have historically treated loss control as a relatively "local" enterprise, whereas it would entail a rather dramatic shift in self-perception for insurers to engage in the activity at a (literally) global scale. Relevant insurer activities fall in the (important) area of pre- and post-disaster loss mitigation, rather than understanding climate science or engaging in the

public policy discussion about mitigating the potential effects of climate change itself. Note that while the climate-change research community uses the word "mitigation" to refer to measures that promise to reduce the threat of climate change, the insurance community uses the term to refer to measures that reduce the likelihood of losses from climate-related (and other) events.

Over the past decade, U.S. insurers have been involved in a large number of activities in which the questions of weather-related losses—and in some cases climate change itself—were addressed. While this history evidences considerably more activity than many outside the insurance community might expect, what does not emerge is a sense that these events have built upon one another towards some sort of consensus on the matter or towards a coordinated plan of action extending beyond preliminary discussion and fact-finding stages. One very positive characteristic of some past efforts is their multidisciplinary approach, in which partnerships with groups outside the insurance sector have been profitably created. However, many barriers remain unresolved, and these cross-cutting partnerships are more the exception than the rule.

The responses of the insurance executives we interviewed paint a picture of insurers who exhibit a genuine desire to make a meaningful contribution toward safeguarding the public and their policyholders. However, most claim to lack the scientific knowledge needed to participate in the climate-change debate. Some stridently declare a lack of expertise and, in the same breath paradoxically state with authority, that climate change is not taking place. Some view the happenings to be "an accident of nature" while others subscribe to the theory that climate change is a cyclical event. Still others support the proposition that the earth's inhabitants, through the burning of fossil fuels and destruction of the rain forests, are contributing to the phenomenon.

Government's role in providing resources for disaster preparedness and recovery and in providing insurance products related to natural disasters is bound to be a moderating factor in insurers' perception of climate-related business risks. The stance of state and federal government (as insurance regulators) is thus fundamental to insurers' outlook, as is the federal government's position in international negotiations on climate change.

Government-sponsored coverage of climate related risks like crop and flood insurance has also insulated U.S. insurers from the full scope of climate related risks,[9] although private insurers do absorb considerable flood losses and some perceive this risk to be growing in the face of climate change. Partially as a result, U.S. insurer attention to climate science has focused largely on wind-related hazards (particularly hurricanes).[10] Relatively little effort has been spent on evaluating other climate-related risks. This narrow focus is justified to a degree given the dominance of windstorms in insurance claims in recent decades, but it also predictably leads to a less-than-comprehensive perspective on the climate change phenomenon.

Many (Surmountable) Barriers Exist

Based on our in-depth interviews and our other research, we offer two ways of analyzing the barriers to more proactive involvement of insurers in the climate change issue. At the highest level, we discern three basic types of "perceptual barriers":

- Uncertainties regarding the science of climate change
- Distrust, parochialism, and provincialism among stakeholders
- Lack of knowledge, and failures of understanding

[9] Total estimated losses from the 1988 U.S. drought were $56 billion, and those from the 1993 Mississippi River Valley floods were $23 billion ($1998). Combined U.S. flood losses for the period 1987-1997 amounted to approximately $65 billion, inflation-corrected to 1995 dollars (Rosenzweig *et al.* 2000).

[10] And, ironically, the U.S. is in a period of reduced hurricane activity, possibly as a consequence of climate change.

stemming from insufficient dialog among stakeholder groups

Underlying these perceptual barriers, we identify a series of barriers and influences that fall into the categories of "legal and regulatory", "technical and informational", "economic and market", and "political".

Legal and regulatory barriers include a lack of imperative from regulators and resistance to new modeling techniques — the taxation of reserve funds set aside for future losses — disallowed recovery of R&D costs — prohibitions against raising prices or withdrawing from at-risk markets mandated involvement in climate change mitigation — and concern that negative experiences such as those with Superfund (liability for pollution) and OSHA (liability for customer emissions reductions or monitoring) will be repeated.

Technical and informational barriers include imperfect data on historical losses — scientific uncertainties and unfounded claims (on both sides of the issue), often amplified by the media — limited ability of climate models to generate results in timeframes and spatial scales that are applicable to insurers — absence of in-house climate expertise — inability of the industry's retrospective "CAT" (catastrophe) models to evaluate prospective scenarios of future climates affected by greenhouse-gas emissions or other causes — and unknown or unfamiliar risk-management characteristics of climate change mitigation technologies.

Economic and market barriers include "supply side" issues such as: more pressing market conditions, competition, and consolidation — the perception that future loss costs are easily recovered through rate and/or deductible increases — soft market conditions that make it particularly difficult for insurers to spend money on research and to differentiate rates to reward environmentally friendly practices among their customers — perception of an immense capacity of alternative risk financing mechanisms — the presence of risk-pooling systems and government-financed insurance and loss-reducing programs that insulate insurers from some of the most uncertain kinds of natural disaster events. There is also suspicion that reinsurers are exaggerating climate change warnings to sell more of their product, and a proactive versus reactive "corporate culture" among some insurers. The economic barriers also include "demand-side" issues such as: lack of imperatives from shareholder and consumer groups — the virtual absence of demand for "green products" and associated corporate behavior in the insurance marketplace — aversion to climate change politics among customers that produce greenhouse-gas emissions — and a host of reasons that encourage insurance buyers to underestimate their true exposures.

Political barriers include the fact that insurance is not a "polluting" industry — peer pressure from major industries participating in the Global Climate Coalition — a general desire to avoid involvement in government initiatives — a specific negative perception of the United Nations (thus tainting the UNEP Insurance Industry Initiative) — concern about identifying their concern only to become the object of tightened solvency requirements or scrutiny and criticism and expectations on the part of environmental activists — regulatory pressure to assume uninsurable risks — becoming the object of a tug-of-war between government, industry, and consumer groups — and competing "social causes" and limited funds to support them.

U.S. insurers are generally not experts in climate-change economics, and some perceive the reduction of greenhouse gases as an unaffordable public policy. It is also notable that U.S. insurers have yet to publicly discuss the potential business opportunities that climate change avoidance/mitigation may offer to them and others in the business community.